849 NW STATE ROAD 45
NEWBERRY, FL 32669 USA
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FCC PART 90 & IC RSS 119
COMBO TEST REPORT

APPLICANT	LAIRD CONTROLS NORTH AMERICA INC
	655 N. RIVER ROAD NW SUITE A WARREN OH 44483-2254 USA
FCC ID	CN286942
IC ID	1007A-86942
MODEL NUMBER	86942 TRX
PRODUCT DESCRIPTION	400 MHZ RF MODULE
DATE SAMPLE RECEIVED	11/27/2017
DATE TESTED	12/13/2017
TESTED BY	Tim Royer
APPROVED BY	Franklin Rose
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Version Number	Description	Issue Date
2035AUT17TestReport	Rev1	Initial Issue	12/21/2017
	Rev2	Revised Report	2/15/2018
	Rev3	Revised Report	2/15/2018

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GENERAL REMARKS

The attached report shall not be reproduced except in full without the written permission of Timco Engineering Inc.

Summary

The device under test does:

☒ Fulfill the general approval requirements as identified in this test report and was selected by the customer.

☐ Not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025 requirements.

I attest that the necessary measurements were made at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669

Tested by:
Name and Title: Tim Royer, Project Manager/Testing Engineer

Sr. EMC Engineer
EMC-003838-NE

Date: 12/18/2017

Reviewed and approved by:
Name and Title: Franklin Rose, Project Manager/Testing Technician

Date: 12/21/2017

GENERAL INFORMATION

EUT Specification

EUT Description	400 MHZ RF MODULE
FCC ID	CN286942
IC	1007A-86942
Model Number	86942 TRX
Operating Frequency	450-470MHz
Test Frequencies	450.75, 459 & 468.965 MHz
Type of Emission	6K81F1D
Modulation	FSK
EUT Power Source	☐ 110–120Vac/50– 60Hz
	☒ DC Power 12V
	☐ Battery Operated Exclusively
Test Item	☐ Prototype
	☒ Pre-Production
	☐ Production
Type of Equipment	☐ Fixed
	☒ Mobile
	☐ Portable
Test Conditions	The temperature was 24-26ºC with a relative humidity of 50 - 65%.
Modification to the EUT	None
Test Exercise	The EUT was operated in a normal mode.
Applicable Standards	ANSI/TIA 603-D:2010, FCC CFR 47 Part 90, & IC RSS 119 i12 2015
Test Facility	**Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA.**

RF POWER OUTPUT

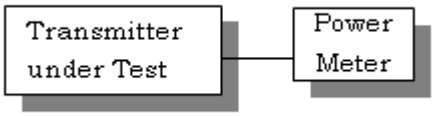
Rule Part No.: Part 2.1046(a), Part 90, RSS-119

Requirements: For IC the power output must be within ±1.0dB of the manufacturers rating.

Method of Measurement: RF power is measured by using a 50-ohm, resistive wattmeter to the RF output connector. With a nominal battery voltage (if battery operated), or a properly adjusted power supply (if not battery operated), and the transmitter properly adjusted the RF output measures:

For the device with a fixed or integral antenna, the RF power is measured as ERP. The substitution method was used. The RF output measures:

Test Setup Diagram:



Test Data:

Tuned Freq (MHz)	Channel	Pconducted (dBm)	Pconducted (W)
450.75	1	26.31	0.4
459	8	26.90	0.5
468.625	F	27.34	0.5

Part 2.1033 (C)(8) DC Input into the final amplifier

INPUT POWER: (12V) (0.62A) = 7.4 Watts

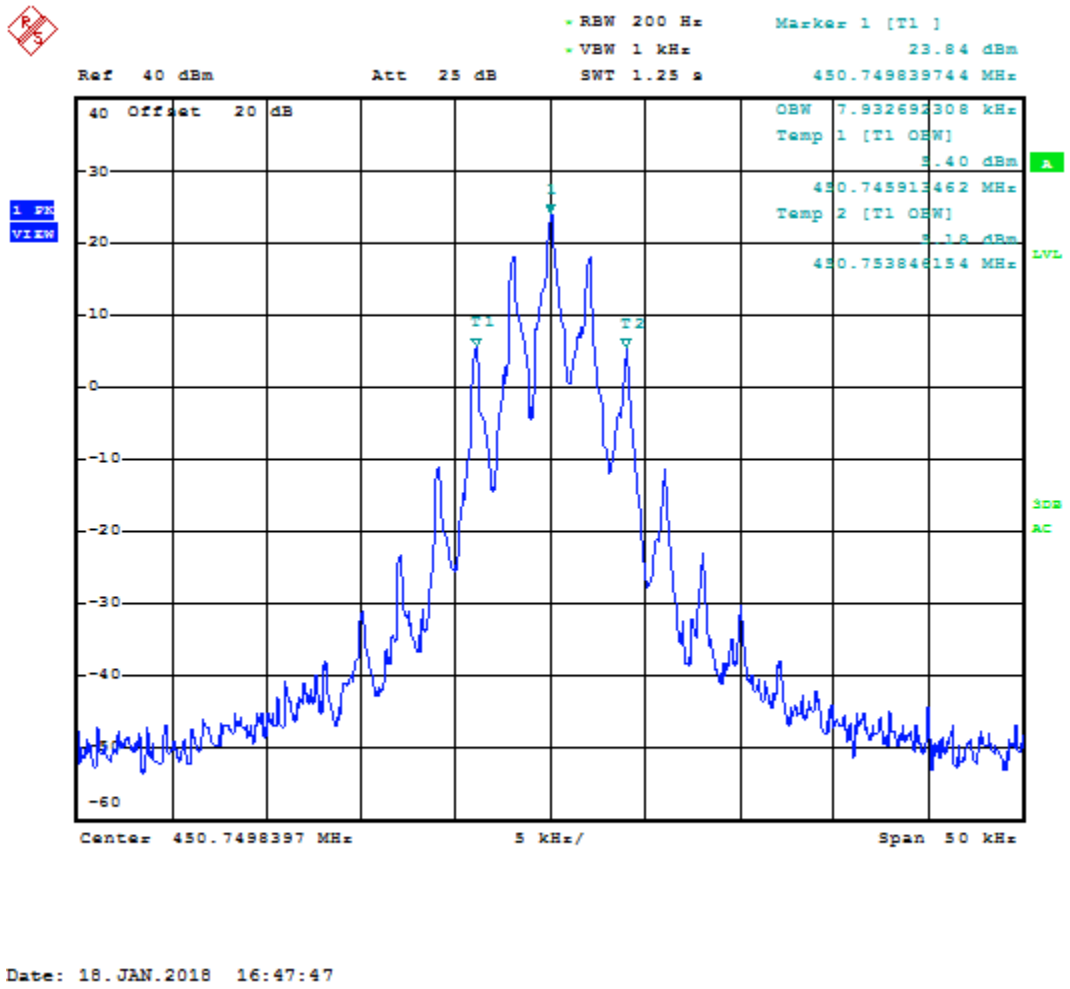
MODULATION CHARACTERISTICS

MODULATION CHARACTERISTICS

Requirements: Part 2.1033(c), 2.1033(c) (4), 2.1047(a) (b), 90.209, 90.207, IC RSS 119

TEST FREQ. 450.75 MHz

99% dB OCC BW = 6.81 kHz



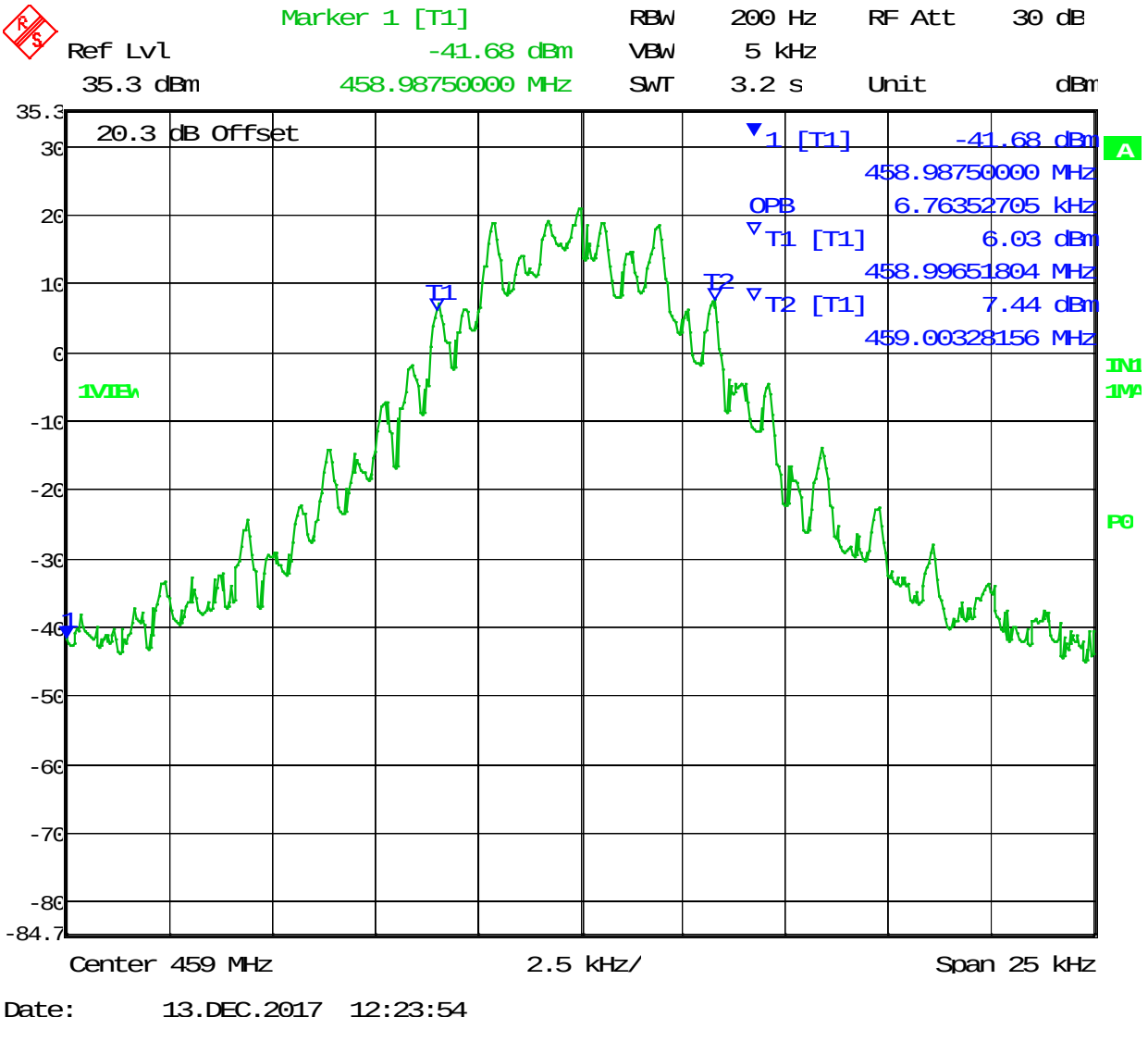
Results Meet Requirements

MODULATION CHARACTERISTICS

Requirements: Part 2.1033(c), 2.1033(c) (4), 2.1047(a) (b), 90.209, 90.207, IC RSS 119

TEST FREQ. 459 MHz

99% dB OCC BW = 6.76 kHz



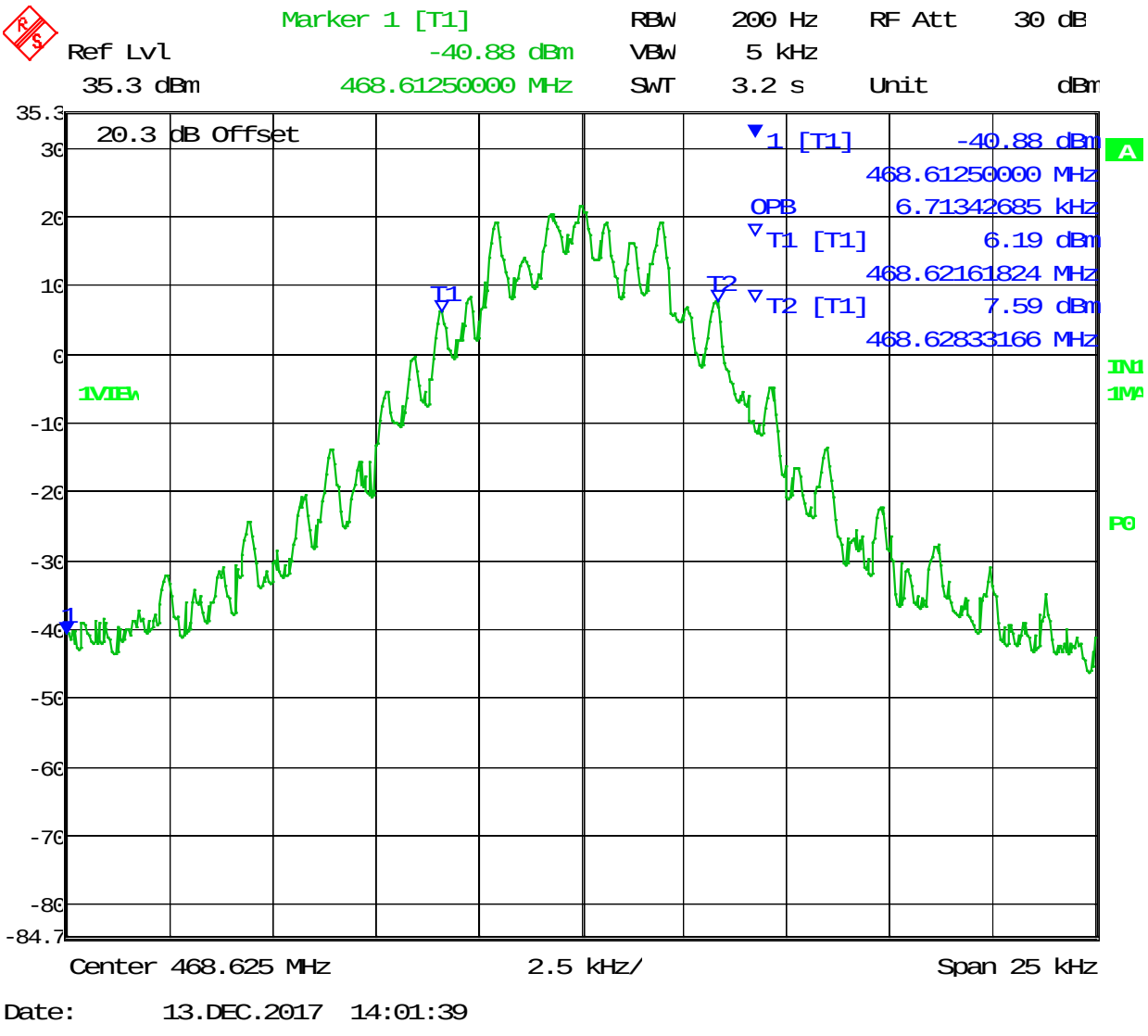
Results Meet Requirements

MODULATION CHARACTERISTICS

Requirements: Part 2.1033(c), 2.1033(c) (4), 2.1047(a) (b), 90.209, 90.207, IC RSS 119

TEST FREQ. 468.965 MHz

99% dB OCC BW = 6.71 kHz



Results Meet Requirements

OCCUPIED BANDWIDTH

Part 2.1049(c) EMISSION BANDWIDTH:

Part 90.210(d) Emission Mask D - 12.5 kHz channel BW equipment.

For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

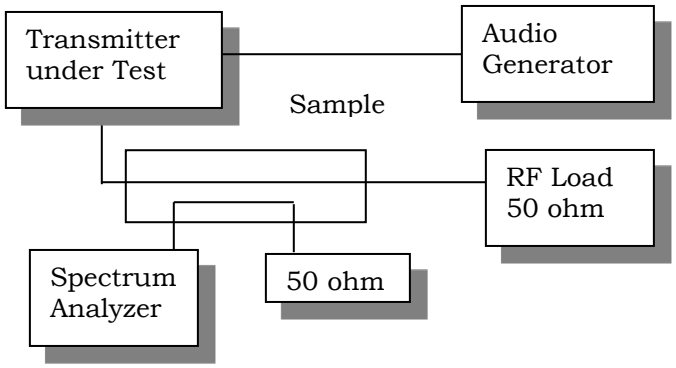
(2) On any frequency from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27 (fd - 2.88 kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10log (P) dB or 70 dB, whichever is the lesser attenuation.

OCCUPIED BANDWIDTH

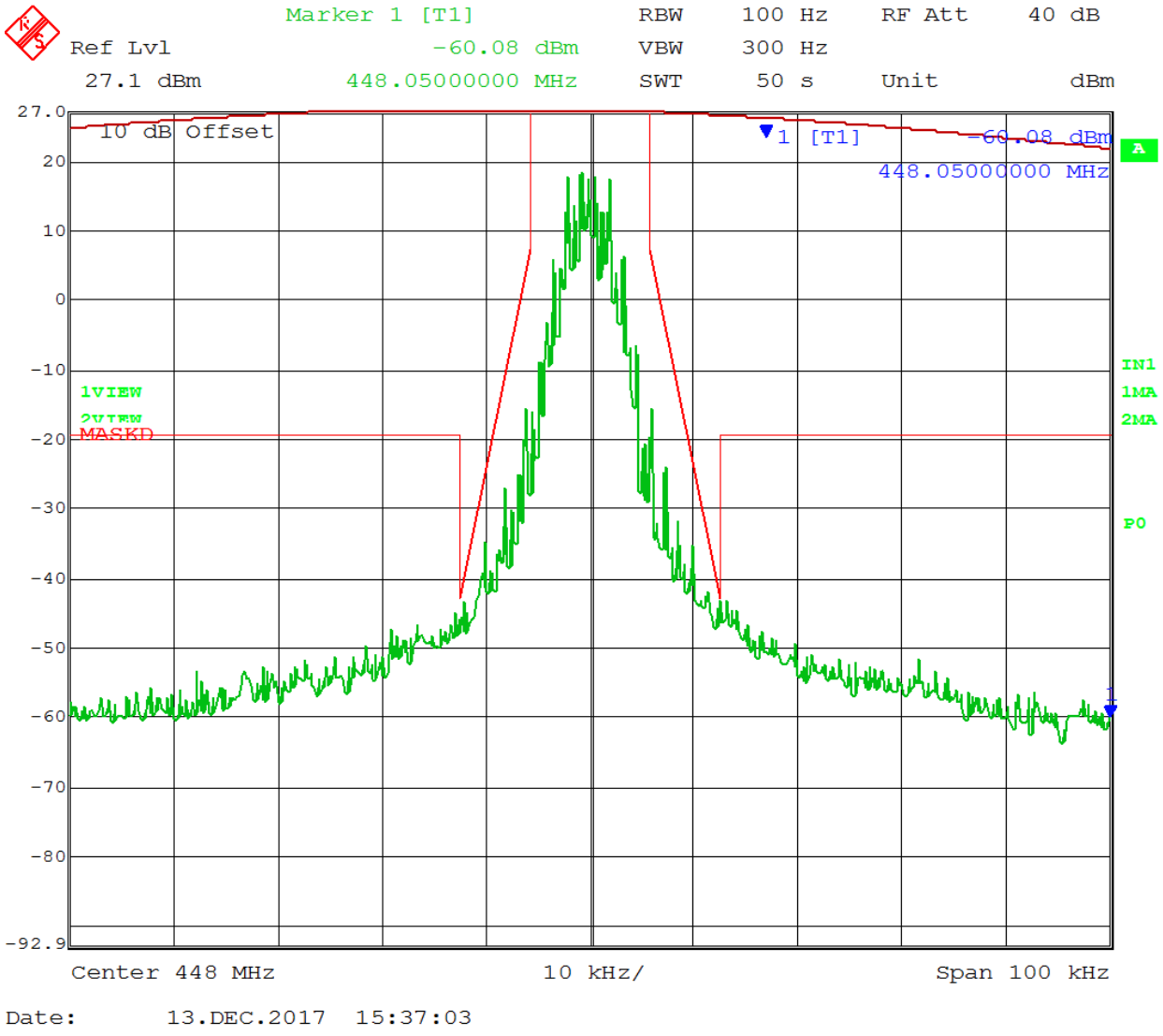
Method of Measurement: Was in accordance with test procedures detailed in the standard list above.

Test Setup Diagram:



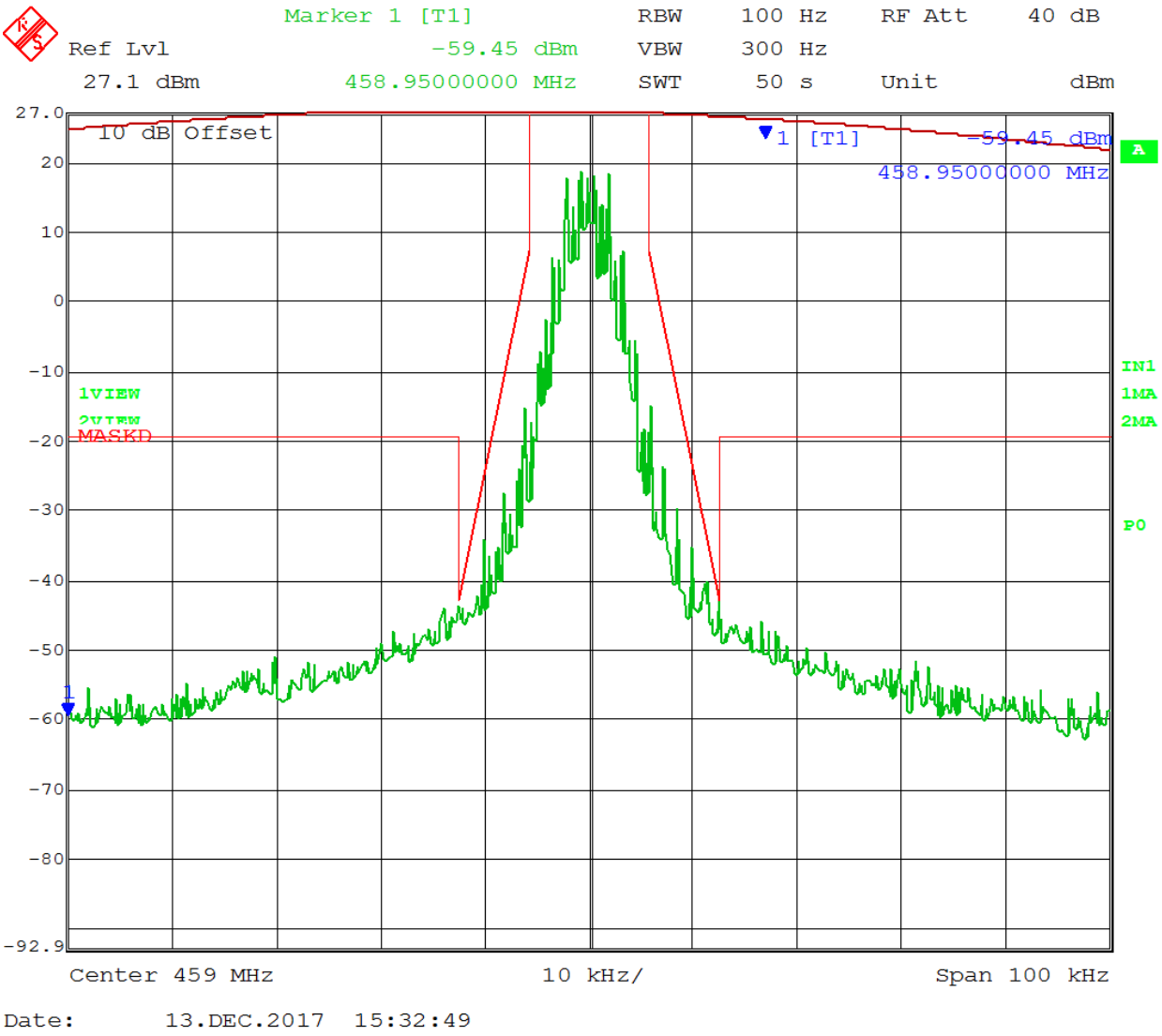
Test Data: See the plots below

Part 90.210(c) Emission Mask D – 12.5 kHz channel



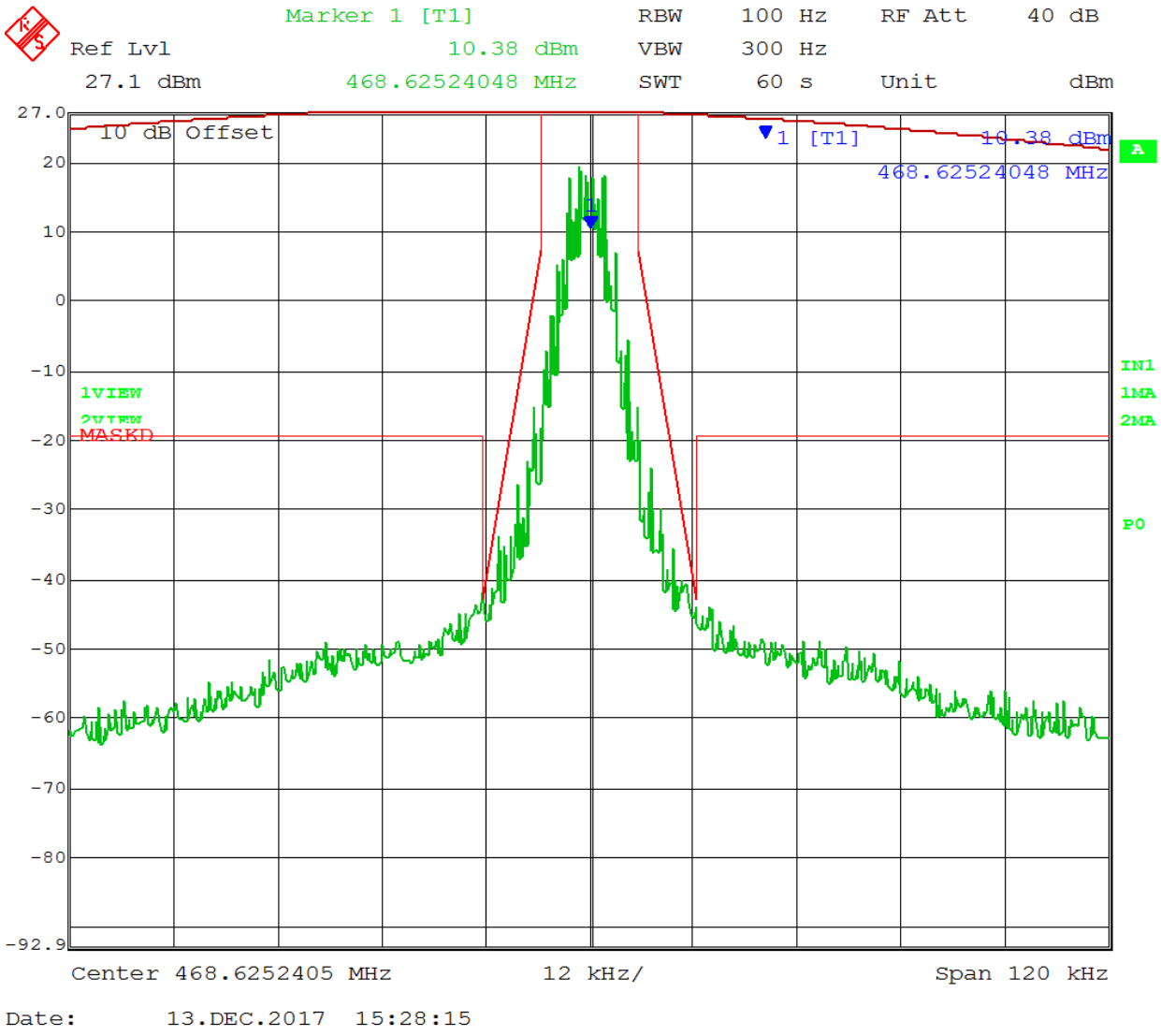
Date: 13.DEC.2017 15:37:03

Part 90.210(c) Emission Mask D – 12.5 kHz channel



OCCUPIED BANDWIDTH 468.965 MHz 12.5kHz Digital

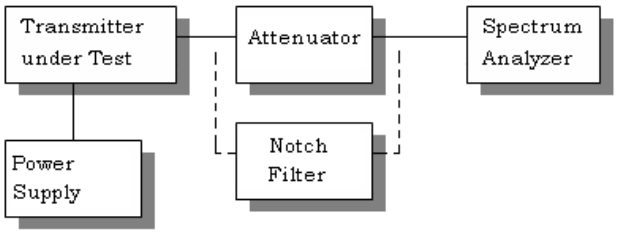
Part 90.210(c) Emission Mask D – 12.5 kHz channel



SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Rule Part No.: Part 2.1051(a)

Method of Measuring Conducted Spurious Emissions



Requirements:

12.5 kHz Channel Spacing = 50+10log (0.5) =47.0dBc

Method of Measurement: The carrier was modulated using the supplied test tone. The spectrum was scanned from 9k to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard test procedures detailed in the standard list above.

Test Data: 448 MHz

Power Output	dBm	Watts	Limit (dBc)
	26.51	0.45	46.51

Frequency		dBc	Margin dB
(fundamental)	450.750	0.00	0.00
	901.500	48.33	1.82
	1352.250	58.97	12.46
	1803.000	57.45	10.94
	2253.750	77.88	31.37
	2704.500	83.61	37.10
	3155.250	83.40	36.89
	3606.000	82.51	36.00
	4056.750	82.51	36.00
	4507.500	80.50	33.99

* Indicates Noise Floor

SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Test Data: 459 MHz

Power Output	dBm	Watts	Limit (dBc)
	26.9	0.49	46.9

Frequency		dBc	Margin dB
(fundamental)	459.000	0.00	0.00
	918.000	49.60	2.70
	1377.000	58.44	11.54
	1836.000	56.03	9.13
*	2295.000	70.24	23.34
*	2754.000	66.19	19.29
	3213.000	70.24	23.34
*	3672.000	70.24	23.34
*	4131.000	70.24	23.34
*	4590.000	70.24	23.34

* Indicates Noise Floor

SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Test Data: 468.965 MHz

Power Output	dBm	Watts	Limit (dBc)
	27.34	0.54	47.34

Frequency		dBc	Margin dB
(fundamental)	468.965	0.00	0.00
	937.930	62.54	15.20
	1406.895	71.25	23.91
	1875.860	86.79	39.45
	2344.825	87.15	39.81
	2813.790	89.05	41.71
*	3282.755	87.85	40.51
	3751.720	87.82	40.48
	4220.685	87.82	40.48
*	4689.650	85.31	37.97

* Indicates Noise Floor

FIELD STRENGTH OF SPURIOUS RADIATION EMISSIONS

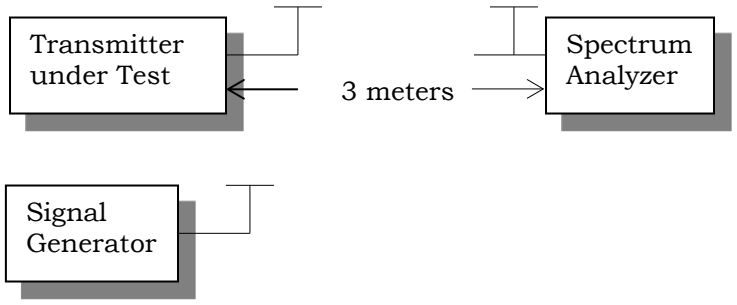
Rule Parts. No.: Part 2.1053, 90.210, 90.543(c)(f), IC RSS 119

Requirements:

12.5 kHz Channel Spacing = 50+10log (0.5) =47.0dBc

METHOD OF MEASUREMENT: The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from 30 MHz to at least the tenth harmonic of the fundamental. This test was conducted in accordance with test procedures detailed in the standard list above using the substitution method. Measurements were made at the test site of **TIMCO ENGINEERING, INC. located at 849 NW State Road 45, Newberry, FL 32669.**

Test Setup Diagram:



FIELD STRENGTH OF SPURIOUS RADIATION EMISSIONS

Rule Parts. No.: Part 2.1053

Test Data: 448 MHz

Power Output	dBm	Watts	Limit (dB)
	26.51	0.45	46.51

Tuned Freq MHz	Emission Frequency MHz	Antenna Polarity	erp (dBm)	Margin dB
450.75	901.50	H	-56.3792	36.38
450.75	901.50	V	-61.2592	41.26
450.75	1352.25	V	-50.6720	30.67
450.75	1352.25	H	-54.2520	34.25
450.75	1803.00	H	-45.1992	25.20
450.75	1803.00	V	-45.5192	25.52
450.75	2253.75	V	-39.1732	19.17
450.75	2253.75	H	-46.1232	26.12
450.75	2704.50	H	-45.7192	25.72
450.75	2704.50	V	-48.5392	28.54
450.75	3155.25	V	-45.0504	25.05
450.75	3155.25	H	-47.1904	27.19
450.75	3606.00	H	-39.8416	19.84
450.75	3606.00	V	-39.8416	19.84
450.75	4056.75	V	-39.4084	19.41
450.75	4056.75	H	-39.4084	19.41
450.75	4507.50	H	-38.5272	18.53
450.75	4507.50	V	-38.5272	18.53

FIELD STRENGTH OF SPURIOUS RADIATION EMISSIONS

Test Data: 459 MHz

Power Output	dBm	Watts	Limit (dB)
	26.9	0.49	46.9

Tuned Freq MHz	Emission Frequency MHz	Antenna Polarity	erp (dBm)	Margin dB
459.00	918.00	H	-56.4132	36.41
459.00	918.00	H	-56.3132	36.31
459.00	1377.00	V	-47.9156	27.92
459.00	1377.00	H	-48.4956	28.50
459.00	1836.00	H	-38.5472	18.55
459.00	1836.00	H	-43.7372	23.74
459.00	2295.00	H	-47.5127	27.51
459.00	2295.00	V	-39.6927	19.69
459.00	2754.00	V	-39.0424	19.04
459.00	2754.00	H	-39.0424	19.04
459.00	3213.00	H	-37.7094	17.71
459.00	3213.00	V	-37.7094	17.71
459.00	3672.00	V	-36.8196	16.82
459.00	3672.00	H	-36.8196	16.82
459.00	4131.00	H	-36.6193	16.62
459.00	4131.00	V	-36.6193	16.62
459.00	4590.00	V	-35.4342	15.43
459.00	4590.00	H	-35.4342	15.43

FIELD STRENGTH OF SPURIOUS RADIATION EMISSIONS

Test Data: 459 MHz

Power Output	dBm	Watts	Limit (dB)
	27.34	0.54	47.34

Tuned Freq MHz	Emission Frequency MHz	Antenna Polarity	erp (dBm)	Margin dB
468.62	937.24	H	-55.4000	35.40
468.62	937.24	V	-56.4800	36.48
468.62	1405.86	H	-44.8179	24.82
468.62	1405.86	V	-45.4879	25.49
468.62	1874.48	V	-39.8772	19.88
468.62	1874.48	H	-38.8072	18.81
468.62	2343.10	V	-47.4912	27.49
468.62	2343.10	H	-47.4912	27.49
468.62	2811.72	H	-46.7443	26.74
468.62	2811.72	V	-46.7443	26.74
468.62	3280.34	H	-37.3790	17.38
468.62	3280.34	V	-37.3790	17.38
468.62	3748.96	V	-36.3485	16.35
468.62	3748.96	H	-36.3485	16.35
468.62	4217.58	H	-35.9314	15.93
468.62	4217.58	V	-35.9314	15.93
468.62	4686.20	V	-35.0069	15.01
468.62	4686.20	H	-35.0069	15.01

FREQUENCY STABILITY

Rule Parts. No.: Part 2.1055, Part 90.213, IC RSS 119

Requirements: Temperature range requirements: -30 to +50º C.
Voltage Variation +, -15%
±2.5 PPM

Method of Measurements: Was in accordance with test procedures detailed in the standard list above.

Test Data:

Temperature	Frequency MHz	Hz	PPM
25°C (reference)	447.99974		
-30°C	448.0008	1060	2.366
-20°C	448.00011	370	0.826
-10°C	447.99961	-130	-0.290
0°C	447.99939	-350	-0.781
10°C	447.99938	-360	-0.804
20°C	447.99974	0	0.000
30°C	447.99983	90	0.201
40°C	447.99964	-100	-0.223
50°C	447.99958	-160	-0.357
Battery Voltage	Frequency	Hz	PPM
-15%	447.99973	-10	-0.022
15%	447.99976	20	0.045

TRANSIENT FREQUENCY RESPONSE

RULE PARTS. NO.: 90.214, IC RSS 119

Requirements: Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals[1] [2]	Maximum frequency difference[3]	All equipment	
		150 to 174 MHz	421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t_1[4]	±25.0 kHz	5.0 ms	10.0 ms
t_2	±12.5 kHz	20.0 ms	25.0 ms
t_3[4]	±25.0 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t_1[4]	±12.5 kHz	5.0 ms	10.0 ms
t_2	±6.25 kHz	20.0 ms	25.0 ms
t_3[4]	±12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			
t_1[4]	±6.25 kHz	5.0 ms	10.0 ms
t_2	±3.125 kHz	20.0 ms	25.0 ms
t_3[4]	±6.25 kHz	5.0 ms	10.0 ms

[1] t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t_1 is the time period immediately following t_{on}.

t_2 is the time period immediately following t_1.

t_3 is the time period from the instant when the transmitter is turned off until t_{off}.

t_{off} is the instant when the 1 kHz test signal starts to rise.

[2] During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in §90.213.

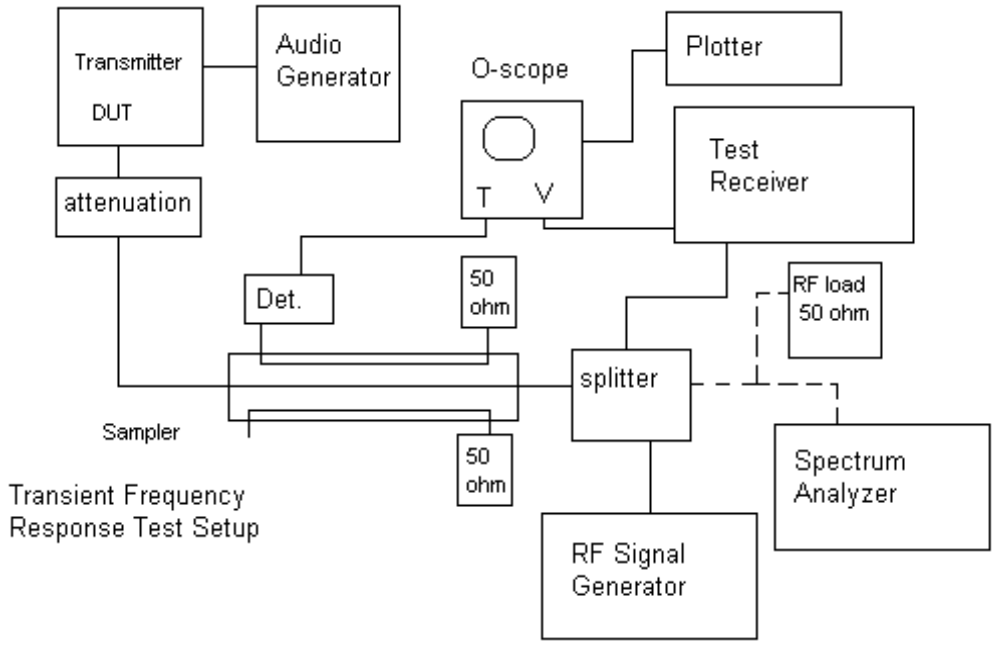
[3] Difference between the actual transmitter frequency and the assigned transmitter frequency.

[4] If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

TRANSIENT FREQUENCY RESPONSE

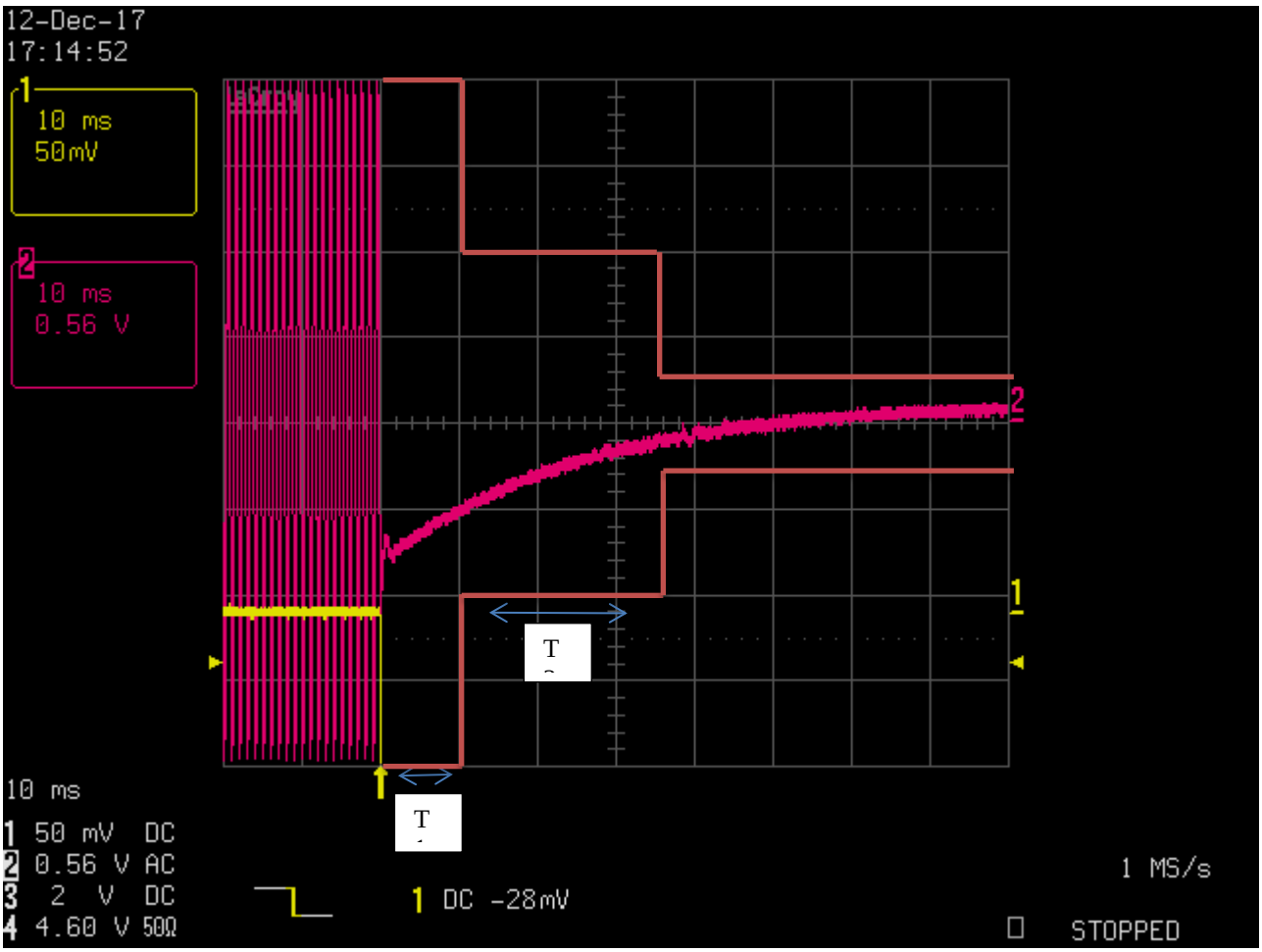
METHOD OF MEASUREMENTS: ANSI/TIA-603 § 2.2.2 Carrier Frequency Stability

TEST SETUP DIAGRAM:



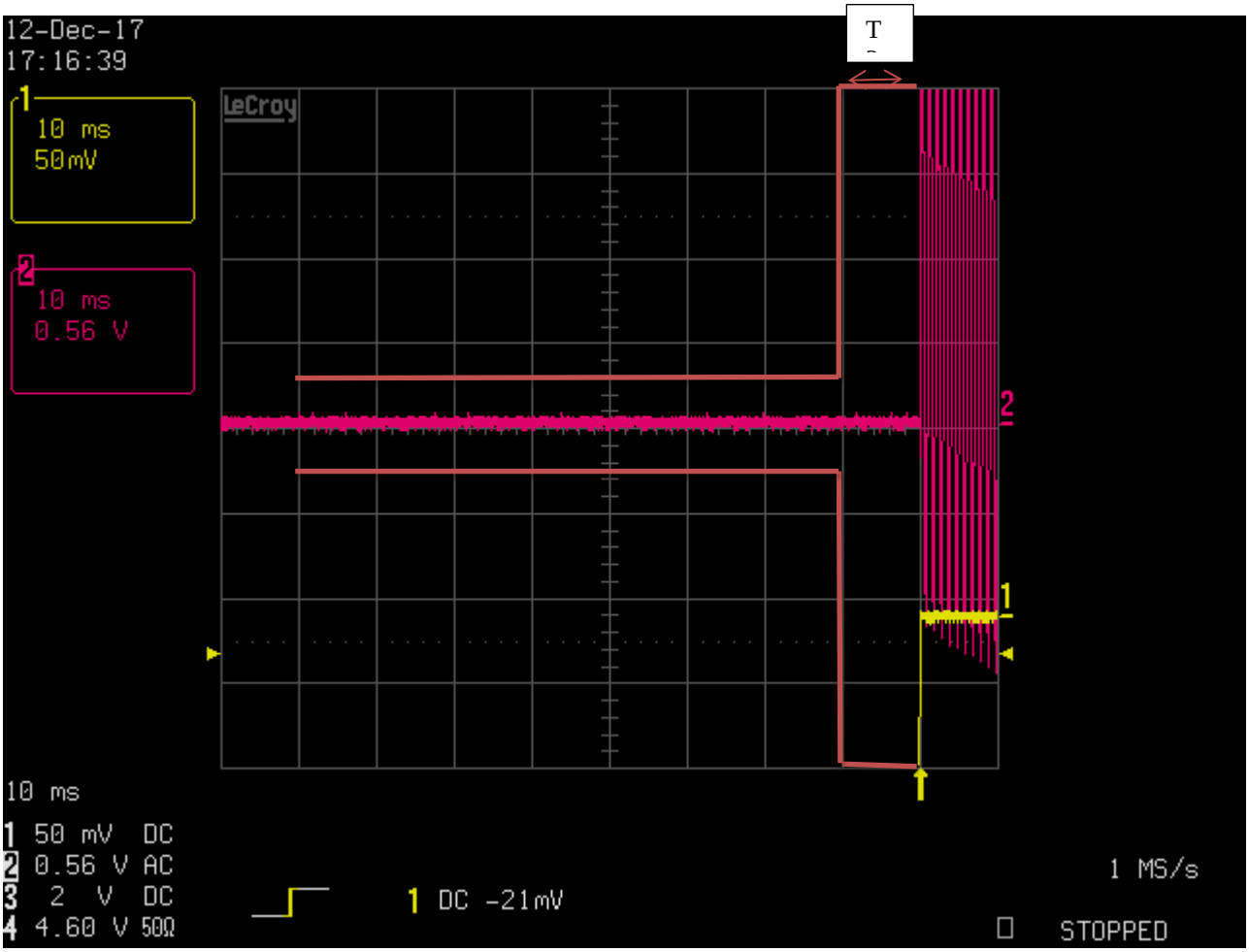
Transient Frequency Response Test Setup

Test Data: 12.5 KHz Channel Spacing Turn On



Results meet requirements

Test Data: 12.5 KHz Channel Spacing Turn Off



Results meet requirements

STATE OF THE MEASUREMENT UC

The data and results referenced in this document are true and accurate. The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16–4 or ENTR 100-028 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: "Uncertainty in EMC Measurements" and is documented in the Timco Engineering, Inc. quality system according to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Timco Engineering, Inc. is reported:

Test Items	Measurement Uncertainty	Notes
RF Frequency Accuracy	± 49.5 Hz	(1)
RF Conducted Power	±0.93dB	(1)
Conducted spurious emission of transmitter valid up to 40GHz	±1.86dB	
Occupied Bandwidth	±2.65%	
Audio Frequency Response	±1.86dB	
Modulation limiting	±1.88%	
Radiated RF Power	±1.4dB	
Maximum frequency deviation: Within 300 Hz and 6kHz of audio freq. Within 6kHz and 25kHz of audio Freq.	 ±1.88% ±2.04%	
Rad Emissions Sub Meth up to 26.5GHz	±2.14dB	
Rad Emissions Sub Meth up to 18-40 GHz	±2.04%	
Adjacent channel power	±1.47dB	(1)
Intermodulation - Tx	±2.07dB	
Noise Figure	±1.00dB	
Transient Frequency Response	±1.88%	
Temperature	±1.0°C	(1)
Humidity	±5.0%	
Radiated Emissions to 6.0GHz	± 4.4dB	
Power line conducted emissions	± 3.9dB	

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=1.96.

EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
12 Volt Power Supply	Astron	RS-12A	9312779	N/A	N/A
Antenna: Biconical 1096	Eaton	94455-1	1096	08/01/17	08/01/19
Antenna: Log-Periodic 1122	Electro-Metrics	LPA-25	1122	07/26/17	07/26/19
Temperature Chamber LARGE	Tenney Engineering	TTRC	11717-7	09/01/16	09/01/18
Frequency Counter Small Chamber	HP	5385A	3242A07460	08/22/17	08/22/19
Coaxial Cable - Chamber 3 cable set (backup)	Micro-Coax	Chamber 3 cable set (backup)	KMKM-0244-02 ; KMKM-0670-01; KFKF-0197-00	N/A	N/A
CHAMBER	Panashield	3M	N/A	04/25/16	05/31/18
Sweep/Signal Generator	Anritsu	68369B	985112	11/08/17	11/08/19
Antenna: Double-Ridged Horn/ETS Horn 2	ETS-Lindgren	3117	00041534	03/01/17	03/01/19
Software: Field Strength Program	Timco	N/A	Version 4.10.7.0	N/A	N/A
Antenna: EMCO Passive Loop	EMCO	6512	1211	07/26/17	07/26/19
18 GHz LBHCD Crystal Detector	Keysight	8470B	MY51340829	N/A	N/A
Type K J Thermometer	Martel	303	080504494	11/06/17	11/06/19
EMI Test Receiver R & S ESU 40 Chamber	Rohde & Schwarz	ESU 40	100320	04/01/16	04/01/18
Waverunner Digital Scope	LeCroy	LT364L	00414	01/26/2016	01/26/2018
Coaxial Cable - BMBM-0130-00 Black	Alpha Wire		BMBM-0130-00	05/24/16	05/24/18
Splitter 1-1000MHz	Mini-Circuits	ZFSC-4-1-BNC+	U115700825	N/A	N/A
Directional Coupler 20dB	HP	X752D	1829A24209	N/A	N/A
Attenuator K 6dB 2W DC-40G	Narda	4768-6	1044-2	N/A	N/A
Bore-sight Antenna Positioning Tower	Sunol Sciences	TLT2	N/A	N/A	N/A
Tunable Notch Filter 250-850 MHz	Eagle	TNF-200	250-850 MHz (#19)	01/19/17	11/19/19

*EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

END OF TEST REPORT